Technology Opportunity
Glenn Research Center • Cleveland • Ohio
Technology Transfer & Partnership Office
TOP3–00163

Lithium Polymer Batteries

Technology

A rod-coil polymer that combines high ionic conductivity with dimensional stability.

Benefits

This technology will enable solid polymer lithium batteries to operate at room temperature conditions. Solid polymer lithium batteries offer many advantages over other battery designs

- Low cost
- Lightweight
- High specific energy
- Improved safety
- Flexible design

Commercial Applications

- Electrolyte for solid polymer lithium batteries
- Proton exchange membrane for fuel cells

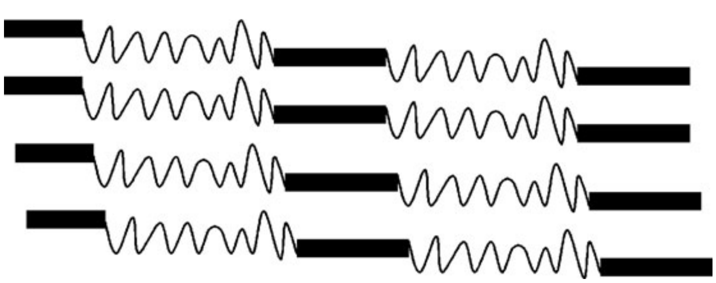

Figure 1a.—Sketch showing the separate rod and coil phases of this material.

Technology Description

Lithium polymer batteries offer cost and performance advantages over other types of batteries; however, today's solid polymer batteries can only operate at elevated temperatures because the solid polymer electrolytes have unacceptable ionic conductivities below 60 °C. Below this temperature, higher conductivity can be achieved by adding solvent to the polymer electrolyte, but the solvent compromises the electrolyte's dimensional and thermal stability. The resulting gel system requires elaborate packaging, and flammability is a concern.

Scientists at the NASA Glenn Research Center have developed an electrolyte material that solves these problems. This new material comprises a series of rod-coil block copolymers in which rigid polyimide rods alternate with very flexible coils of polyethylene oxide (PEO). Figure 1 shows a sketch of the rod-coil structure and an atomic force microscope (AFM) image of a rod-coil sample. Because the rods and coils are incompatible, the blocks tend to phase separate. The result is a polymer with nanoscale channels of ionically conducting PEO alternating

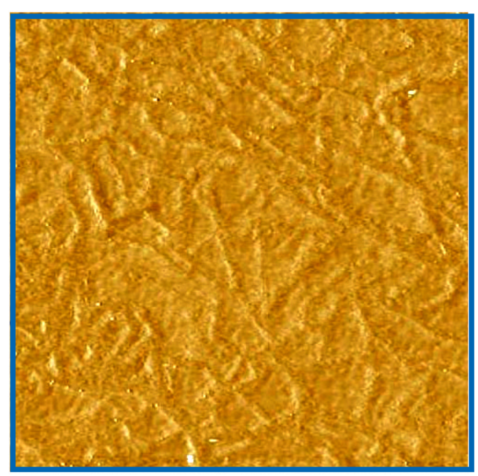

Figure 1b.—AFM image showing modulus differences for the "stiff" rods and "soft" coils.

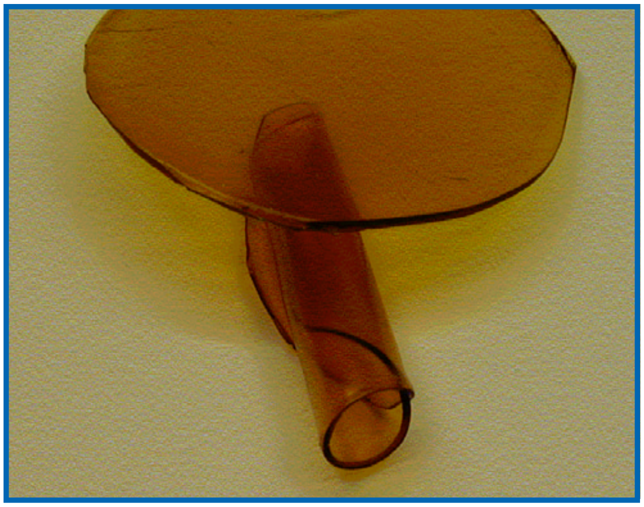

Figure 2.—Samples of material with good conductivity and material integrity.

with concentrations of the rigid rods. The rod regions form the mechanical support for the conducting PEO coils, resulting in a material with both good conductivity and mechanical integrity. Figure 2 shows two samples of this material, with one coiled up to demonstrate its mechanical integrity.

While NASA Glenn Researchers continue to develop this rod-coil material to improve its performance, they have already achieved some impressive results. Figure 3 shows conductivity versus temperature curves for NASA's rod-coil material compared to state-of-the-art PEO material. The rod-coil material's curve is flatter as a function of temperature, so at lower temperatures it has

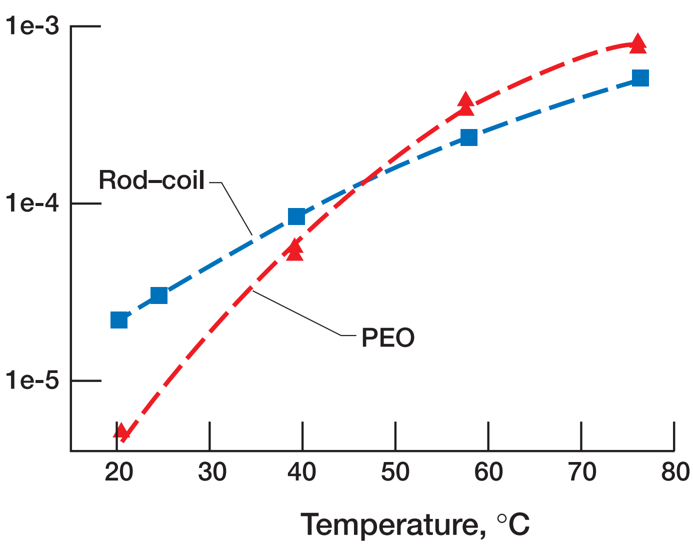

Figure 3.—Conductivity versus temperature curves.

significantly higher conductivity than PEO; at 20 °C the rod-coil material has almost an order of magnitude greater conductivity. It is important to note that NASA's results are for solvent-free samples.

Options for Commercialization

NASA is looking for partners to commercialize this rod-coil polymer technology. A patent application has been filed for this technology, so NASA's preference is to license this technology to companies who will use it in their commercial products.

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References

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Key Words

Polymer
Lithium battery
Electrolyte
Polyethylene oxide